expressed should avoid them. But Mr. Harte's thoughts are so good, the images in his mind are so original, that his works are certain to fascinate the reader in spite of the slovenly mannerism of his writing. One of the bad results of an inferior style and of a want of proper reticence in a writer is that the reader who has read but a little of him is likely to conceive a mean opinion of him. It is necessary to read a great deal of Mr. Harte to have a right opinion of his works. They form together a picture of the life, landscape, and society which the author saw in his youth; the picture lies in the author's mind as a whole, and should so lie in the reader's mind; a thought or image of Mr. Harte's which, taken by itself, might appear to be of no great significance, will become much more interesting when it is seen as part of this picture.

E. S. Nadal.

Art. IV. — The Triumph of Darwinism.

It is not often that the propounder of a new and startling scientific theory has lived to see his daring innovations accepted by the scientific world in general. Harvey's great discovery of the circulation of the blood was scoffed at for nearly a whole generation; and Newton's law of gravitation, though proved by the strictest mathematical proof, received from many eminent men but a slow and grudging acquiescence. Even Leibnitz, who as a mathematician hardly inferior to Newton himself might have been expected to be convinced on simple inspection of the theory, was prevented from accepting it by the theological objection that it appeared to substitute the action of a physical force for the direct action of the Deity. In France, where ideas not of French origin are very apt to be but slowly apprehended, the opposition to the Newtonian theory was not silenced till 1759, when Clairaut and Lalande, by calculating the retardation of Halley's comet, furnished such crucial proof as could not possibly be overcome. At this time Newton had been thirty-two years in his grave; seventy-two years had elapsed since the publication of the "Principia," and ninety-four since the hypothesis was first definitely conceived.

In the present age, when the number of scientific inquirers has greatly increased and the interchange of thoughts has become rapid and constant, it takes much less time for a new generalization to make its way into people's minds. It is now barely eighteen years since Mr. Darwin's views on the origin of species were announced in a book which purported to be only the rough preliminary sketch of a greater work in course of preparation. But, though greeted at the beginning with ridicule and opprobrium, the theory of natural selection has already won a complete and overwhelming victory. One could count on one's fingers the number of eminent naturalists who still decline to adopt it, and the hesitancy of these appears to be determined in the main by theological or metaphysical, and therefore not strictly relevant, objections. But it is not simply that the great body of naturalists have accepted the Darwinian theory: it has become part and parcel of their daily thoughts, an element in every investigation which cannot be got rid of. With a tacit consent that is almost unanimous, the classificatory relations among plants and animals have come to be recognized as representing degrees of genetic kinship. One needs but to read constantly such scientific journals as "Nature," or to peer into the proceedings of scientific societies, to see how thoroughly all contemporary inquiry is permeated by the conception of natural selection. The record of research, whether in embryology, in palæontology, or in the study of the classification and distribution of organized beings, has come to be the registration of testimony in support of Mr. Darwin's hypothesis. So deeply, indeed, has this mighty thinker impressed his thoughts on the mind of the age that in order fully to unfold the connotations of the word "Darwinism" one could hardly stop short of making an index to the entire recent literature of the organic sciences. The sway of natural selection in biology is hardly less complete than that of gravitation in astronomy; and thus it is probably true that no other scientific discoverer has within his own lifetime obtained so magnificent a triumph as Mr. Darwin.

The comparison of the doctrine of natural selection with the Newtonian theory is made advisedly, as I wish to call attention to some differences in the aspect of the proofs by which two such different hypotheses are established. First, however, as the point will not hereafter come up for consideration in this paper, it may

be well to notice the theological objection which has been urged against Mr. Darwin, as it was once urged against Newton, and to show briefly why, as above hinted, it cannot be regarded as properly relevant to the discussion of the scientific hypothesis. The theological objection to natural selection, which has weight with many minds, is precisely the same objection that Leibnitz made to gravitation, — that the action of physical forces appears to be substituted for the direct action of the Deity. This has, indeed, been a very common objection to theories which enlarge and define what is called the action of secondary causes, but it has been peculiarly unfortunate in this respect, that with the progress of inquiry it has invariably been overruled without practical detriment to theism. It regularly happens that the so-called atheistical theory becomes accepted as part and parcel of science, and yet men remain as firm theists as ever. The objection is, therefore, evidently fallacious, and the fallacy is not difficult to point out. It lies in a metaphysical misconception of the words "force" and "cause." "Force" is implicitly regarded as a sort of entity or dæmon which has a mode of action distinguishable from that of universal Deity; otherwise it is meaningless to speak of substituting the one kind of action for the other. But such a personification of "force" is a remnant of barbaric thought, and is in no wise sanctioned by physical science. When astronomy speaks of two planets as attracting each other with a "force" which varies directly as their masses and inversely as the squares of their distances apart, it simply uses the phrase as a convenient metaphor by which to describe the manner in which the observed movements of the two bodies occur. It explains that in presence of each other the two bodies are observed to change their positions in a certain specified way, and this is all that it means. This is all that a strictly scientific hypothesis can possibly allege, and this is all that observation can possibly prove. Whatever goes beyond this and imagines or asserts a kind of "pull" between the two bodies, is not science but metaphysics. An atheistic metaphysics may imagine such a "pull," and may interpret it as the "action" of something that is not Deity, but such a conclusion can find no support in the scientific theorem, which is simply a generalized description of phenomena. The general considerations upon which the belief in the existence and direct action of Deity are otherwise

founded, are in no wise disturbed by the establishment of any such scientific theorem. The theological question is left just where it was before. We are still at perfect liberty to maintain that it is the direct action of Deity which is manifested in the planetary movements; having done nothing more with our Newtonian hypothesis than to construct a happy formula for expressing the mode or order of the manifestation. We may have learned something new concerning the manner of Divine action; we certainly have not "substituted" any other kind of action for it. And what is thus obvious in this simple astronomical example is equally true in principle in every case whatever in which one set of phenomena is interpreted by comparison with another set. In no case whatever can science use the words "force" or "cause" except as metaphorically descriptive of some observed or observable sequence of phenomena. And consequently at no imaginable future time, so long as the essential conditions of human thinking are maintained, can science even attempt to substitute the action of any other power for the direct action of Deity. Darwinism may convince us that the existence of highly complicated organisms is the result of an infinitely diversified aggregate of circumstances so minute as severally to seem trivial or accidental; yet the consistent theist will always occupy an impregnable position in maintaining that the entire series in each and every one of its incidents is an immediate manifestation of the creative action of God.

From an obverse point of view it might be argued that since a philosophical theism must regard Divine power as the immediate source of all phenomena alike, therefore science cannot properly explain any particular group of phenomena by a direct reference to the action of Deity. Such a reference is not an explanation, since it adds nothing to our previous knowledge either of the phenomena or of the manner of Divine action. The business of science is simply to ascertain in what manner phenomena coexist with each other or follow each other, and the only kind of explanation with which it can properly deal is that which refers one set of phenomena to another set. In pursuing this its legitimate business science does not trench on the province of theology in any way, and there is no conceivable occasion for any conflict between the two. From this and the previous considerations

taken together it follows not only that such explanations as are contained in the Newtonian and Darwinian theories are entirely consistent with theism, but also that they are the only kind of explanations with which science can properly concern itself at all. To say that complex organisms were directly created by the Deity is to make an assertion which, however true in a theistic sense, is utterly barren. It is of no profit to theism, which must be taken for granted before the assertion can be made; and it is of no profit to science, which must still ask its question, "How?"

Setting aside, then, the theological criticism as irrelevant to the question really at stake, the Darwinian theory, like the Newtonian, remains to be tested by strictly scientific considerations. In the more recent instance, as in the earlier, the relevant question is how far the course of events as sketched by the hypothesis agrees with the observed phenomena of nature. But in the directness with which this question can be answered there is great difference between the two theories. The Newtonian hypothesis asserted the existence of a general physical property of matter, and could therefore be tested by a single crucial instance, such as was afforded by the simple case of the planetary motions. Kepler's three laws comprised in succinct form a very complete description of the movements of the planets, and when it was shown that these movements were just such as must occur according to the theory of gravitation, the theory was rightly regarded as verified. Further confirmatory instances could but repeat the same lesson, as when the irregularities of movement, due to the attractions exercised by the various planets upon each other, were likewise seen to conform strictly to the hypothesis. Nor was any alteration or enlargement of the original theory required in order to obtain the supreme triumph of verified prediction, as when Clairaut foretold the precise amount of delay in the reappearance of Halley's comet caused by the interfering attractions of Jupiter and Saturn, or as when Leverrier and Adams discovered the existence of Neptune through its effects upon the motions of Uranus. In all these cases the physical principle involved was simple, and admitted of precise mathematical treatment; and it is owing to this that the law of gravitation has become the most illustrious example which the history of science can furnish of a completely verified hypothesis.

To look for similar conciseness of verification in the case of the Darwinian theory would be to mistake entirely the conditions under which scientific evidence can be procured. To estimate properly the value of any hypothesis it is necessary that we should know what kind and degree of proof to expect; and in the present case we must not look for a demonstration that shall be direct and simple. Instead of a universal property of matter, so conspicuous as to be recognized at once by the inspection of a few striking instances, we have in the theory of natural selection to deal with a very complex process working results of endless diversity throughout the organic world, and often masked in its action by accompanying processes, some of which we can detect without being able to estimate their relative potency, while others no doubt have thus far escaped our attention altogether. Accordingly, while we may consider it as certain that natural selection is capable of working specific changes in organisms, we may at the same time find it impossible to give a complete account of the origin of any one particular species through natural selection, because we can never be sure that we have taken due notice of all the innumerable concrete circumstances involved in such an event. The theory, therefore, cannot be adequately tested by any single striking instance, but must depend for its support on the cumulative evidence afforded by its general harmony with the processes of organic nature.

If we consider the Darwinian theory as a whole, it must be admitted that such cumulative evidence has already been brought forward in sufficient quantity to amount to a satisfactory demonstration. The convergence of proofs is too persistent and unmistakable to allow of any alternative hypothesis being put in the field. But in exhibiting this, it is desirable that there should be no confusion of thought as to the full import of the Darwinian theory. Mr. Mivart's way of describing that theory as an attempt to account for the origin of all the various forms of life through the operation of natural selection alone, is a gross misrepresentation. Mr. Darwin has never urged his hypothesis in this limited shape. The essential theorems of Darwinism are, *first,* that forms of life now widely unlike have been produced from a common original through the accumulated inheritance of minute individual modifications; and, *secondly,* that such modifications have been ac-

cumulated mainly, or in great part, through the selection of individuals best fitted to survive and transmit their peculiarities to their offspring. But that this survival of the fittest individuals has been the sole agency concerned in bringing about the present wondrous variety of living beings, Mr. Darwin has nowhere asserted or implied, having even in the earliest edition of his great work explicitly pointed out certain other agencies as involved in the complex result. Yet other agencies, hitherto unsuspected, may be discovered in the future; but such discoveries, however far they may go in supplementing the Darwinian theory, can only strengthen its central position as regards the rise of specific differences through gradual modifications.

That natural selection is a true cause, and one capable of accumulating variations to an indefinite extent, is now held to be beyond question. The wonders wrought by artificial selection in the breeding of domestic animals and cultivated plants are such that one might well have attributed great results to the exercise of a similar selection by Nature through countless ages, could any such process be detected. Few, however, save those instructed naturalists who have frequent occasion to ponder the subject, are aware what a tremendous reality natural selection is. As I have elsewhere observed, "a single codfish has been known to lay six million eggs within a year. If these eggs were all to become adult codfishes, and the multiplication were to continue at this rate for three or four years, the ocean would not afford room for the species. Yet we have no reason to suppose that the race of codfishes is actually increasing in numbers to any notable extent. With the codfish, as with animal species in general, the numbers during many successive generations oscillate about a point which is fixed, or moves but slowly forward or backward. Instead of a geometrical increase with a ratio of six millions, there is practically no marked increase at all. Now this implies that out of the six million embryo codfish a sufficient number will survive to replace their two parents, and to replace a certain small proportion of those contemporary codfishes who leave no progeny. Perhaps a dozen may suffice for this, perhaps a hundred. The rest of the six million must die." * The amount of destruction is not so great as

* Outlines of Cosmic Philosophy, Vol. II. p. 12.

this in all parts of the animal kingdom. Among the higher birds and mammals the preservation of the individual bears a very much higher ratio to the preservation of the race. But with the immense classes of fishes, insects, and crustaceans, as well as the sub-kingdom of molluscs, — which taken together make up by far the greater portion of the animal world, — the destruction continually going on is probably not less than that which is described in the example cited. Even if we were to take account only of the individuals which survive the embryo or larva state, but do not succeed in leaving offspring behind them, the cases of destruction would still bear an enormous ratio to the cases of preservation. But in maintaining the characteristics of a race only those individuals can be counted who produce offspring. It is obvious then that each species of organisms, as we know it, consists only of a few favored individuals selected out of countless multitudes who have been tried and rejected as unworthy to live. No selection that is exercised by man compares in rigor with this. It is somewhat as if a breeder of race-horses were to choose, with infallible accuracy of judgment, the two or three fleetest out of each hundred thousand, destroying all the rest that the high standard of the breed might run no possible risk of deterioration. In such a rigorous competition as this, no individual peculiarity can be so slight that we are entitled to regard it as unimportant. No peculiarity is really slight that enables its possessor to survive until he transmits it to posterity.

In view of all this we see how misleading it is to describe natural selection (as Mr. Mivart does) as a process which operates only occasionally upon variations assumed to be fortuitous. We see that natural selection, like a power that slumbers not nor sleeps, is ever preserving the stability of species by seizing all individual peculiarities that oscillate within narrow limits on either side of the mean that is most advantageous to the species, while cutting off all such peculiarities as transgress these limits. Domesticated animals, protected from the exigencies of wild life, often exhibit great varieties in coloring, while wild animals of the same genus or species are monotonously colored, because only one kind of coloring will aid them in catching prey or eluding enemies, and all the variations are killed out. Who can doubt that antelopes are so fleet, only because all but the fleetest individuals are sure to be

overtaken and eaten by lions? Protected from the lions, a thousand generations might well make them as lazy and clumsy as sheep.

Operating in this stern way, natural selection secures the general adaptation of each race of organisms to the conditions of life which surround it. And so long as a species continues surrounded by circumstances that are tolerably persistent, natural selection maintains its stability of character. Thus what the older naturalists called the "fixity of species" is fully accounted for. But a "fixity of species" that is maintained only under such conditions is really no fixity at all. Change the surrounding circumstances and the average character of the species must change. Slight peculiarities that once insured survival will now insure destruction, and tendencies to vary that once would have been nipped short will now be encouraged and exaggerated. In this way the strong tendency, hereditary in all mammals, toward the growth of hair on the surface was greatly exaggerated in the Siberian mammoth, while checked in his brethren, the elephants of India and Africa. In this way a peculiar curve in the contour of butterflies' wings, which is persistently killed out in India and Java, is with equal persistency selected for preservation in Celebes. How far such alterations in the direction of natural selection may work deep-seated changes in the structure of an organism, one cannot accurately define; but there is no doubt that they go very far indeed, when taken in connection with the facts of what is called "correlation of growth." An organism is not a mere aggregation of parts, of which one can be altered without affecting the others. Increase in the size and weight of a deer's horns entails an increase in the size of the cervical vertebræ and muscles, and indirectly modifies the shoulders and fore-limbs; while all these changes, by altering the animal's centre of gravity, cause compensating changes in the rest of the body. Increased thickness of fur modifies the efficiency of the skin as an excreting organ, and thus reacts upon the lungs, liver, and kidneys. But it is not only in these clearly traceable ways that correlation of growth is manifested. Sometimes the correlations are inexplicable. Thus, to lengthen the beak of a pigeon is to increase the size of his feet, hairless dogs have their teeth imperfect, and white tomcats with blue eyes are almost invariably deaf. In the present state of physiological knowledge we cannot account for such facts; but it is enough for

the purposes of the Darwinian theory to know that they exist. For, taken all together, they show that natural selection, operating on even the most superficial variations, is quite competent to work deep-seated changes of structure and function.

When we consider, then, that the circumstances which determine what individuals shall survive are not constant in the long run for any species, though apparently constant for limited periods of time; when we reflect that there is no one of the larger groups of plants and animals — such as orders, or families, or even genera — which has not been subjected again and again to great and complicated changes of environment, it becomes evident that anything like "fixity of species" is utterly out of the question. No such thing is possible or even imaginable, when once the facts of the case have been thoroughly conceived. Looking over the earth's surface to-day, things may seem quiet and stable enough. But if we contemplate the succession of past events, as disclosed by the geologist, what mainly strikes our attention is the secular turmoil. Islands aggregating into continents; continents breaking up into archipelagoes; rivers shifting their beds; coast-lines changing their direction; oceans now separated by impassable isthmus-walls, now mingling their floras and faunas through new-made channels; torrid zones becoming temperate, and temperate zones growing frigid; marshes transformed into deserts, and glaciated valleys thawing into sunny lakes; high table-lands sinking into ocean-floors, and submarine ledges rearing their heads as Alpine ranges; deep-sea molluscs and crustaceans seeking refuge in shallow waters, while littoral organisms migrate upland to find new food and contend with new enemies; plant-seeds carried by vagrant birds to unwonted habitats; peaceful tribes of ruminants decimated by invading carnivores; ceaseless conflict, and redistribution of every possible sort, — these are the things we are called upon to contemplate. Remembering, then, how stability of species is maintained only by the rigorous selection of a few individuals that are best adapted to a given set of exigencies, we see that, as the combinations of exigencies are altered from time to time, the stability of species can in general be but temporary. Now and then we may expect to find very long persistency of type where, in spite of great terrestrial changes, some simple set of conditions most important to the organism remains unaltered; but in the vast majority of cases such persistence is

impossible. It is seldom that the life of any species extends over more than one geological epoch; often the duration is much shorter than this.

Whether, therefore, it is practicable for us to-day to explain every minute peculiarity of any one particular species by an appeal to natural selection alone, is not the main point to be considered in estimating the success of the Darwinian theory. The question has a scientific interest of its own which is very great, but it is not the main question. The main point is that, admitting natural selection to be a *vera causa* at all (and this no one denies), the stability of species is proved to be but a contingent and temporary affair. The old notion of an absolute fixity of species is overthrown once for all, and with it the only semblance of an argument that could ever have been alleged in behalf of the hypothesis of special creations. For in considering nearly allied forms, like the lion, tiger, and leopard, their actual consanguinity would never have been doubted for a moment but for the inability of naturalists to understand how the type which appears so constant, when viewed through a short period of time and amid unchanging conditions, should after all be variable. Unable to imagine any probable cause or method of variation by which the descendants of a common feline ancestor should have acquired the divergent characters of lions and leopards, the naturalist either gave up the problem as insoluble, or else retreated upon the assumption that leopards and lions were separately created. In either case science was equally at fault, for, as above argued, the hypothesis of special creations, as referring a particular group of phenomena to that Divine action which is the equal source of all phenomena, is not entitled to be considered a scientific explanation. But when Mr. Darwin called attention to the working of natural selection, the difficulty was removed, and it at once became highly probable that such allied forms had diverged from a common stock through the accumulation of minute modifications.

Such being the conclusion to which we are led by considering the process of natural selection, it becomes desirable to inquire whether the conclusion is confirmed by the most general phenomena of organic life that have been observed and tabulated. There is no hesitation or ambiguity in the answer. Whether we consider the classificatory relationships of plants and animals, their embry-

ology, their morphology, their geographical distribution, or their geological succession, there is not only abundance of evidence, but the evidence points wholly in one direction. With entire unanimity the phenomena in question testify that species have arisen by descent with modifications and not by disconnected acts of creation. The facts of classification alone are sufficiently decisive. By the older naturalists who sought to arrange animals and plants in groups according to their resemblances, attempts were often made to construct a linear series in which each group should be intermediate between those which preceded and those which followed it. All such attempts proved futile, and after a half-century of discussion and criticism it became evident that the only possible classification which correctly represents the facts is one in which organisms are arranged in divergent groups and sub-groups, like the branches and twigs of what is aptly termed a family tree. Wherever different orders, families, or genera show points of resemblance to each other, the resemblances occur always at the bottom, among their least highly developed species. Apes, bats, and rabbits are sufficiently distinct in type, but the lowest members of the orders to which these animals respectively belong are strikingly like one another. At the bottom of the mammalian class, the echidna and duck-bill have many points in common with birds and reptiles; while birds and reptiles not only draw together so that it is hard to distinguish their most primitive forms as clearly bird or clearly reptile, but these primitive forms remind one in many ways of the batrachians. A batrachian, in turn, is an animal which ends its life as a kind of reptile after having begun it as a kind of imperfectly specialized fish. Again, the lowest known vertebrate, the amphioxus, — usually ranked with fishes, though hardly specialized enough to be called a true fish, — exhibits marks of actual relationship with the ascidian, which is nothing more than a worm of the order known as tunicata. No two animals could be less like each other than a bee and a nautilus, yet in their lowest members the two sub-kingdoms of articulata and molluscs become barely distinguishable from each other and from the worms with which the vertebrate sub-kingdom also becomes blended. It is on account of this convergence of types as we descend in the scale that naturalists have found it so difficult to classify satisfactorily those lower organisms which Cuvier roughly

grouped together as radiata. Parallel phenomena recur as we reach the confines of the animal and vegetal kingdoms and meet with numbers of organisms which there is as much reason for assigning to the one kingdom as to the other. All this complicated arrangement of organisms in groups within groups, resembling each other at the bottom of the scale and differing most widely at the top, is just what is presupposed by the Darwinian theory of "descent with modifications," and on any other theory it appears to be totally inexplicable.

Precisely similar testimony as to gradual divergence is found in the facts of embryology and morphology. It is a familiar fact that the germs of all organisms are like each other, and are, moreover, very like such lowest forms of life as the amœba and protococcus. But as a germ develops it becomes specialized and defined, first as to its sub-kingdom, then as to its class, order, family, genus, species, and variety. The germ-cell of a mandril is at first indistinguishable from that of a snail or lobster. The fœtal ape arising therefrom is at first definable as a vertebrate, but not as a mammal; on the other hand, it circulates its blood through a system of gills, and its naşcent heart is like the heart of a fish. Presently, with the appearance of the allantoidal membrane, the fœtus seems to be on the point of becoming a reptile or bird; but after a while it declares itself a mammal. Next it becomes apparent that it is not a rodent or insectivore, but a primate; next, it exhibits characteristics which define it as a true ape, and not a lemur; still later, it is seen to be a catarrhine ape; and finally, it is born with the specific attributes of a mandril, which are, however, further intensified as it reaches maturity. Facts like these, which are invariably found in the embryonic development of organisms, tell just the same story as the facts of classification. If they do not mean that the various forms of organic life have arisen by gradual divergence from a common original, one might well be excused for doubting whether the phenomena of nature have any rational meaning whatever. Of like import are many of the more special facts of embryology, such as the useless rudiments of hind limbs in many snakes, the presence of teeth in the beaks of sundry embryonic birds and in the jaws of fœtal whales, and the gill-like glands in the human throat. And as if all this were not enough, the study of morphology discloses that all the diversified mechan-

ical functions performed by the various animals comprised in any sub-kingdom are achieved by more or less considerable modifications of a framework that in its typical features is common to all. In embryonic development the fins of the fish correspond with the legs of reptiles and mammals, and with the legs and wings of birds. To enable the bat to fly, no new mechanism is invented, but an embryonal hand develops into a wing by the elongation of its fingers and the growth of the web-like skin between them.

If we consider the most general features of the geographical distribution and geological succession of organisms, we find the evidence hardly less complete and convincing. Generally speaking, the contemporary species found in any geographical area most closely resemble the species that inhabited the same area in former ages. Thus in the Miocene age Australia abounded in marsupials, and marsupials specifically different, though nearly allied to these, make up to-day the greater part of the mammalian fauna of Australia. There is no imaginable reason why this should be so, unless the contemporary marsupials are descended from the earlier forms. It cannot be urged that marsupials are better adapted to the conditions of life in Australia than placental mammals; for the placental mammals lately introduced there are already beginning to supplant and exterminate the marsupials. The only possible explanation is that, whereas marsupials once covered the terrestrial globe, and have been supplanted by better adapted forms in the Old World and (with the exception of the opossum) in America, on the other hand the isolation of Australia has allowed them there to go on reproducing their kind until the present day. In such an instance as this we have something very nearly like crucial proof of the theory of "descent with modifications." In like manner the extinct edentata of South America are closely allied to the living ant-eaters, sloths, and armadilloes. So, too, the indigenous floras and faunas of islands lying near continents always resemble the floras and faunas of the continents near which they lie. The Galapagos archipelago, distant some six hundred miles from the coast of Chili, has a fauna which, though generically distinct from all others, is yet South-American in type, and closely resembles the fauna of Chili. Again, among the animals living on the different islands of this group, we find specific diversity along with generic identity. On the Darwinian theory this

is just what might be expected. The long isolation of the archipelago from the continent has given opportunity for the rise of generic divergences between their once homogeneous faunas; while the briefer isolation of the several islands from each other has been attended by slighter, or specific, divergences; and, as if to complete by contrast the force of the example, we find that the only animals on the archipelago which are not generically different from their allies on the continent are birds, able to fly back and forth over the intervening sea. Unless the Darwinian theory be true, these striking relations not only become meaningless, but it is difficult to see why any discernible relations at all should exist between these neighboring faunas. To cite all the confirmatory facts of this sort would be to write an exhaustive account of the distribution of plants and animals.

In examining the geological record in general, we are struck with its corroboration of the above-cited testimony of classification and embryology. For instance, as we go back in time, we find families and orders drawing more and more closely together; we find earlier forms less specialized than their successors; and as we now have embryonic birds with rudimentary teeth in their beaks, so we find that formerly adult birds with such teeth existed. It is one of the most significant truths of palæontology that extinct forms are generally intercalary between forms now existing, so that not only genera and families, but even orders, of contemporary animals are every now and then fused together by the discovery of extinct intermediate forms. It is in this way that the Cuvierian orders of pachyderms and ruminants have come to be ranked as a single order, the horse and pig being connected by numerous fossil links with the camel and antelope. Until quite lately there has been less success in the attempt to find a perfect series of transitional forms connecting some well-known animal with its generically different ancestor. But the argument heretofore urged against the Darwinian theory, on the ground of this imperfect success, was at best a weak one, as resting merely upon the absence of evidence which further discovery might furnish at any moment. The Darwinian might candidly urge that his failure was due partly to the fragmentary character of the geological record, in which there is no reason for supposing that more than one form out of a hundred has been preserved, and partly to the fact that

only a small portion of the earth's surface has been explored by the palæontologist, and that portion but superficially. The justice of such a plea is rendered apparent, while the hostile argument is completely silenced, by the recent discoveries of Professor Marsh as to the palæontological history of the ancestors of the horse. As these discoveries have just been well described in Professor Huxley's admirable lectures in New York, a brief mention here will suffice to show their import.

One of the most striking peculiarities of the equine genus — including the horse, ass, zebra, and quagga — is the modification of the limbs, so that what appears to be the horse's fore-knee is really his wrist, and what in the hind-limb looks like a reversed knee is really his heel, while the lower halves of the legs are really feet terminating in the middle toe armed with its nail, which we call the hoof. The two adjacent toes are represented only by splint-bones on either side of the middle metacarpal or metatarsal, and the radius and ulna in the fore-limb, as well as the tibia and fibula in the hind-limb, are almost completely fused together. Now according to the Darwinian theory such a highly specialized animal as the horse must be descended from a less specialized mammal in which the limbs were like ordinary mammalian limbs, ending in ordinary feet with five separate toes each. The embryology of the horse points to this conclusion, and here, as usual, but with unwonted emphasis, palæontology confirms the inference. Already in Europe had been found the three-toed hipparion, in which the two side toes were like dew-claws, and the older anchitherium, in which all three toes were complete. But the discoveries of Professor Marsh have set before us a much more perfect series. Going back in time, as we reach the upper Pliocene, the horse disappears, and we find the pliohippus, very much like him. In the lower Pliocene this creature is replaced by the protohippus, with three toes like the hipparion. In the upper Miocene we have the miohippus, with three well-developed toes like the anchitherium, and with the rudiment of a fore-toe on the fore-foot. In the mesohippus of the lower Miocene this rudiment is a splint-bone, like those which represent the later-disappearing toes in the modern horse. By this time we find the ulna and fibula well developed and distinct from the radius and tibia. Still further back, in the upper Eocene, comes the

orohippus, with four complete toes on the fore-foot. And finally, in the lower Eocene, we get the eohippus, which shows the rudiment of a fifth toe on the front and of a fourth toe on the hind foot. In the structure of the teeth — the other chief point in which the modern horse is notably specialized — we find a similar gradation back to the ordinary mammalian type.

The agreement of observed facts with the requirements of theory is here complete, minute, and specific; and Professor Huxley may well say that the history of the descent of the horse from a five-toed mammal, as thus demonstrated, supplies all that was required to complete the proof of the Darwinian theory. The theory not only alleges a *vera causa*, and is not only confirmed by the unanimous import of the facts of classification, embryology, morphology, distribution, and succession; but it has further succeeded in tracing the actual origination of one generic type from another, through gradual "descent with modifications." And thus, within a score of years from its first announcement, the daring hypothesis of Mr. Darwin may fairly claim to be regarded as one of the established truths of science.

JOHN FISKE.

ART. VI. — THE EASTERN QUESTION.

THE title of this article is the name of the oldest existing problem in European politics. All the questions with which the diplomatists of the seventeenth and eighteenth centuries were plagued, except this, have been settled in one fashion or another; but this remains, and is now apparently more difficult than when it first presented itself. The humiliation of the House of Austria, which was the aim of Continental reformers at the close of the sixteenth and the beginning of the seventeenth century; the humiliation of France, which was their aim during the latter part of the seventeenth and the beginning of the eighteenth century; and the reduction of the Pope to a condition of harmlessness, which has been one of their dreams for fully three centuries, have all been accomplished. Indeed, if we look at the points of the Grand Design of Henry the Fourth, as set forth by Sully to Queen Elizabeth, — "the restoration of Germany to its ancient liberty